

# CONSUMPTION OF CALCIUM AMONG AFRICAN AMERICAN ADOLESCENT GIRLS

**Objective:** To determine the adequacy of calcium intake of children by demographic group in the Lower Mississippi Delta (LMD) and compare to national statistics.

**Design:** FOODS 2000 was used to examine the dietary calcium intake of LMD children and compare it to US children in the Continuing Survey of Food Intakes by Individuals (CSFII) 1994–1996, 1998.

**Setting and Participants:** The sample of 465 non-Hispanic children 3–17 years of age who live in 36 counties of the LMD was identified by using list-assisted random digit dialing methods.

**Main Outcome Measures:** The *t* tests and *z* tests were performed for within- and between-sample comparisons. Logistic regression, controlling for energy, race, sex, age, and nutrition assistance was used as a measure of the association of sample characteristics with meeting adequate intake (AI) for calcium. An algorithm was used to calculate the rankings of calcium consumption from food categories.

**Results:** Children in the LMD consumed significantly less calcium ( $P < .05$ ) than children in the US sample. Percent of AI for calcium decreased as age increased. Persons who consumed less than the AI for calcium include females, Blacks, those not receiving nutritional assistance, and older children. Less than 22% of LMD and 27% of US 9- to 17-year-old children met their calcium AI. Sources of calcium were similar across subgroups and all included milk as their top contributor to calcium intake.

**Conclusion:** Interventions are needed to increase adolescents' calcium consumption, with particular focus on 9- to 17-year-old African American girls. (*Ethn Dis.* 2006;16:476–482)

**Key Words:** Calcium, Dietary Intake, Lower Mississippi Delta Nutrition Intervention Research

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## INTRODUCTION

Low calcium intake by individuals is recognized as a public health problem in the United States; >75% of Americans do not meet the current calcium recommendations for their age.<sup>1</sup> Data from calcium balance studies indicate that maximal net calcium balance is achieved with calcium intakes between 1200 and 1500 mg/day for children 9–18 years of age.<sup>2–7</sup> The Food and Nutrition Board of the Institute of Medicine recommends that the adequate intake (AI) of calcium for children ages one through three years is 500 mg/day, children ages four to eight years is 800 mg/day, and children ages 9–18 years is 1300 mg/day.<sup>2</sup> Disorders related to low calcium intake in children include osteoporosis, colon cancer, hypertension, and obesity in adulthood.<sup>8</sup>

Current dietary guidelines for Americans emphasize the need for adequate consumption of calcium-rich foods,<sup>9</sup> mainly milk and dairy products, leafy green vegetables, fruits, seeds,<sup>10</sup> and fortified products.<sup>11</sup> Since 1990, consumption of calcium-rich foods such as milk products has generally decreased, especially among teenaged girls.<sup>12</sup> Most children, especially those 9–18 years of age, have calcium intakes significantly

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*Most children, especially those 9–18 years of age, have calcium intakes significantly lower than recommended.*<sup>13</sup>

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lower than recommended.<sup>13</sup> Less than half of 2- to 18-year-olds consumed an AI of calcium.<sup>14</sup> According to the 1987–1988 Nationwide Food Consumption Survey and the Third National Health and Nutrition Examination Survey (NHANES III), African Americans, residents of the South, and people living in low-income households consume significantly less calcium than comparison groups.<sup>10,13</sup>

Children in the Lower Mississippi Delta (LMD) region of Arkansas, Louisiana, and Mississippi are at considerable risk for inadequate calcium intake and low consumption of calcium-rich foods. The LMD is a rural, agricultural region whose population is ≈49% African American. The LMD population experiences high rates of poverty, unemployment, and chronic disease. A high proportion of LMD children live in food-insecure households and have higher rates of obesity and other health problems.<sup>14–16</sup> In addition, food insecurity in the LMD is estimated to be twice that of the United States.<sup>16</sup>

Before forming the Lower Mississippi Delta Nutrition Intervention Research Initiative (Delta NRI), a nutrition survey had not been conducted that could describe the food intake of children and adults in this region at

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higher risk for health and nutrition problems.<sup>17</sup> The Delta NRI Consortium thus conducted the Foods of Our Delta Survey (FOODS 2000), a telephone-administered, cross sectional survey to assess the dietary intake of households in 36 counties in the LMD.<sup>18</sup>

The purpose of this report is to further describe the adequacy of calcium intake of children ages 3–18 years in the LMD, to compare LMD data to the national Continuing Survey of Food Intakes by Individuals (CSFII) 1994–1996, 1998 sample,<sup>1</sup> and to determine the sources of calcium intake by demographic groups of the sample.

## METHODS

FOODS 2000 was a cross-sectional telephone survey to obtain dietary intake data from a representative sample population three years of age and older in 36 counties of the LMD.<sup>18</sup> The sample was identified by using list-assisted random digit dialing methods. Children were defined as 3–18 years of age. The primary ethnic groups in the Delta are non-Hispanic Caucasians (hereafter referred to as Whites) and African Americans (AA).

### Sample

A two-stage, stratified cluster sampling plan was used.<sup>18</sup> Estimates from the FOODS pilot study<sup>19</sup> and from the CSFII<sup>1</sup> were used to calculate the sample size, with a two-sided test with 5% significance level and 80% power. Based on these estimates, a sample size of 1727 households and 465 children was determined large enough to detect differences from the national data estimates for a variety of dietary outcomes.

### Data Collection Procedures

Telephone interviews were conducted from January to June 2000 by trained interviewers. Training for the dietary interviewers was conducted by

Westat of Rockville, Maryland, which served as the coordinating center for the Lower Mississippi Delta Nutrition Intervention Research Initiative and has conducted similar efforts for the National Health and Nutrition Examination Survey (NHANES) and CSFII. The telephone interviewers were trained in telephone and survey techniques by using home study, demonstration interviews, and interactive lectures and role playing.

Predetermined algorithms were used to randomly select one adult per household and sample children until the designated sample size was obtained. Detailed information on sampling and data collection are published elsewhere.<sup>18</sup> Data on race/ethnicity, education level of each household, household income data, information on participation in nutrition assistance programs, and food eaten by the primary respondent were collected. Dietary intake for the previous 24 hours was obtained from respondents by using the USDA's multiple-pass method.<sup>1</sup> For this study, the 1994–1996 CSFII Food Instruction Booklet was modified slightly to include foods commonly consumed in the LMD. Interviews with children <11 years old were conducted with the assistance of a parent or guardian. Additional information on foods eaten by children away from home was retrieved from personnel at schools and from childcare providers. Before this interview, food measurement guides and a small monetary incentive were mailed to each sample person.

### Dietary Data Processing

As described elsewhere,<sup>18</sup> dietary intake recalls were coded by trained coders using the Pennington Biomedical Research Center (PBRC) dietary coding database system, which uses CSFII diet codes<sup>1</sup> and has been verified to produce the same dietary and nutrient breakdown as CSFII.<sup>1</sup> After initial data entry, a second coder checked each recall to

verify accuracy, and then 100% of the recalls were rechecked by a coding supervisor. For quality control, 10% of all recalls were then re-entered by another coder and compared for consistency. The dataset was sent to the Delta NRI Data Analytic Center to screen for possible errors and outliers (values outside the 95% confidence interval). These data were checked manually against the original questionnaire and corrected.

## Statistical Analysis

Sampling weights for the FOODS 2000 were consistent with the procedures used with the CSFII 1994–96, 1998.<sup>1</sup> A household base weight equal to the inverse probability of selection was assigned to each sampled telephone number. Data were adjusted to compensate for telephone numbers with unknown residential or eligibility status, the number of residential telephones in the household, and screener non-response. To account for nonresponse to the dietary interview, the weight of the nonparticipants was distributed to the participants within adjustment cells defined by age, race, and sex. Finally, estimates were calibrated to 1990 United States Census Bureau estimates of total households by state. The Jackknife II method<sup>20</sup> of calculating variances was used for the FOODS 2000 as well as the CSFII. Levels of all macronutrients, 10 vitamins, and seven minerals consumed were computed from dietary recalls. Percentages of respondents meeting the appropriate dietary reference intakes (DRI) were calculated for all reported nutrients by using Food and Nutrition Board, Institute of Medicine guidelines.<sup>2,21,22</sup>

The following algorithm was used to calculate the rankings of food categories. For each demographic group of interest, the calcium attributable to each food was pooled, and results were ranked. Calcium was summed by person and for each USDA food code; calcium levels were then

merged with per person/food summaries and the sampling weights by person. Similar foods have common prefixes of USDA food codes. The first three digits of the food codes were used to define categories. For each USDA food code category, a weighted sum of calcium was calculated within each demographic group (eg, race and age group). Finally, foods were ranked within demographic group by food group category.

### Estimates and Comparisons

Both the FOODS 2000<sup>18</sup> and CSFII<sup>1</sup> are complex surveys. Statistical analyses were conducted by using SUDAAN, a software package, which uses the survey's sample design to calculate variances.<sup>23</sup>

For comparisons of domains within the FOODS 2000 (eg, LMD Whites vs LMD African Americans), contrast statements were used to perform a series of *t* tests. For comparisons between samples of the FOODS 2000 and CSFII 1994–1996, 1998 surveys, the samples were treated as independent, and *z* tests were conducted. SUDAAN V8.0 and SAS V8.2 statistical software<sup>23,24</sup> were used for the calculations. *P* values were not adjusted for multiple comparisons.

Classification and regression trees<sup>25,26</sup> were used as an exploratory tool to identify demographic groups in the LMD at risk for consuming inadequate calcium. This method helped identify where possible interactions were needed and which variables were potentially important. A logistic regression was developed to model those consuming inadequate calcium using Hosmer-Lemeshow model building approach.<sup>27</sup> Variables used in the classification tree and logistic model were age, self-reported BMI (body mass index), sex, ethnicity, total energy consumed, income, and whether the household participated in nutrition-assistance programs as covariates. Two-way interactions were considered between factors and alternative

forms of the continuous variables (eg, cut points to create categorizations, quadratic terms). The final model included the covariates energy and age and indicator variables for sex, race, and whether the household participated in nutrition-assistance programs.

### RESULTS

Mean calcium intakes from food and percent of calcium (AI) are shown by age for LMD children and the national sample in Table 1. Overall, children in the LMD consumed significantly less ( $P<.0001$ ) calcium than their counterparts in the CSFII sample. Children ages 3–4 and 12–18 years in the LMD consumed significantly less ( $P<.05$ ) calcium than their respective counterparts in the CSFII sample. Lower Mississippi Delta (LMD) teenagers consumed almost 1/2 cup milk per day less than the CSFII national sample and 1-1/2 cups milk less than the AI for calcium.

The mean calcium intakes of children ages three to eight years in both the LMD and the United States exceeded the recommended AI (Table 1). In contrast, mean calcium intakes for LMD and CSFII children ages 9–11 years were 71% and 74%, and for 12- to 18-year-olds 66% and 77% of the AI, respectively. Only 22% of LMD 9- to 11-year-olds and 14% of LMD 12- to 18-year-olds met the AI for calcium as compared to 20% and 22% of their national counterparts.

Mean calcium intake was significantly lower ( $P<.05$ ) in LMD children from middle \$15,000–\$30,000 than higher income ( $> \$30,000$ ) households (Table 1). Mean calcium intake in LMD children did not differ significantly from US children based on household income.

The LMD African American children consumed an average of 795 mg of calcium, which was significantly less ( $P<.05$ ) than LMD White children (Table 1). The LMD White children

consumed an average of 903 mg of calcium, which was significantly less ( $P<.05$ ) compared to 985 mg that their US counterparts consumed.

Lower Mississippi Delta (LMD) boys ( $P<.001$ ) consumed less calcium than their US counterparts. Within the LMD, girls consumed significantly less ( $P<.001$ ) calcium than boys. Mean calcium intake was significantly lower ( $P<.001$ ) for children in LMD households who do not participate in nutrition-assistance programs compared with the national sample, but no difference was seen in households that receive nutritional assistance.

The classification tree identified age and energy intake as variables related to meeting the calcium AI. The tree identified a subgroup of 74 children who failed to meet the calcium AI. These children consumed  $< 1517$  kilocalories (kcal) and were at least seven years old. Odds ratios, shown in Table 2, indicate for each increase of 100 kcal, the odds of meeting the AI for calcium increases by 1.17 ( $P<.0001$ ). Males are 1.7 times more likely to meet calcium AI than females ( $P=.0372$ ). Whites are two times more likely than African Americans to meet the calcium AI ( $P=.0205$ ). Those participating in nutrition-assistance programs were 1.88 times more likely than those not participating to meet calcium AI ( $P=.0171$ ). For each increase in age of one year, the odds for meeting an AI of calcium decreased by a factor of 0.72. Neither income nor BMI was significantly related to meeting the calcium AI for this group.

Milk is the top contributor (28%) to calcium in the diet of all children, followed by grain mixtures (10%). Other top contributors to calcium in the diets of LMD children, listed in descending order, included flavored milk, sandwiches with meat, white bread, frozen milk desserts, natural cheese, processed cheese, and cooked cereals. Top food contributors to calcium intake were similar across race and age. There was a difference in the type of milk consumed by race and age.

**Table 1.** Milligrams of calcium intake (percentage of the AI) for the children in the Lower Mississippi Delta sample by age, income, ethnicity, sex, and use of nutritional-assistance programs compared with CSFII equivalent sample

Subjects	LMD			CSFII		
	n	Mean (% AI)	SE of Mean	n	Mean (% AI)	SE of Mean
<b>Age</b>						
§ Total	485	841 (83)	20.2	7756	932 (93)	10.2
* 3-4 years	57	695 (110)	62.3	3695	853 (138)	8.5
5-8 years	117	833 (104)	39.2	2076	892 (112)	11.3
9-11 years	84	928 (71)	58.4	808	957 (74)	19.4
† 12-17 years	227	853 (66)	34.1	1177	975 (75)	23.5
<b>Income</b>						
<\$15,000	106	820 (80)	41.5	1515	911 (93)	31.4
* ≥\$15,000 to <\$30,000	117	747 (76)¶	45.3	1742	847 (87)	12.2
\$30,000+	193	888 (89)	38.3	4499	964 (95)	13.9
<b>Ethnicity</b>						
African American	265	795 (77)#	30.3	1162	773 (78)	15.9
* White	203	903 (94)	32.7	4859	985 (98)	16.4
<b>Gender</b>						
‡ Male	231	913 (92)**	32.1	3940	1037 (102)	16.2
Female	254	769 (75)	29.8	3816	822 (84)	9.9
<b>Nutritional assistance  </b>						
Receive	239	816 (80)	36.0	3065	891 (91)	17.0
‡ Do not receive	209	826 (85)	33.5	4662	953 (94)	15.3

\*  $P < .05$ .

†  $P < .01$ .

‡  $P < .001$ .

§  $P < .0001$ .

|| Total n different, which indicates a nonresponse by participant for that question.

¶ Significantly different than LMD ≥\$30,000 income ( $P < .05$ ).

# Significantly different than LMD White ( $P < .05$ ).

\*\* Significantly different than LMD female ( $P < .001$ ).

AI=adequate intake; CSFII=Continuing Survey of Food Intakes by Individuals.

Nine- to 17-year-old White children reported consuming 2% low-fat milk, while whole milk was the top calcium source for African American children.

## DISCUSSION

The current study illustrates the exceptionally low calcium intake of children in the LMD region compared to the nationwide sample. The LMD teenagers consumed almost 1/2 cup milk per day less than the CSFII national sample and 1-1/2 cups milk less than the AI for calcium. Previous research in this population has shown high rates of obesity and hypertension.<sup>16,18</sup> Increasing calcium intake has

been shown in several studies to address these medical conditions.<sup>28-35</sup> Cardiovascular disease is the leading cause of death among adult African Americans. National health agencies estimate that 36% of adult African Americans have high blood pressure, and more than 60% are overweight.<sup>36</sup> Clear evidence shows a relationship between low dairy product intake and elevated blood pressure levels in individuals and in populations at increased risk of hypertension.<sup>37-42</sup> Additionally, both observational and clinical studies have suggested that dairy product consumption favorably affects weight loss and/or maintenance.<sup>43-46</sup> According to Skinner et al,<sup>47</sup> children could reduce their body fat by 0.4% if they increased their

**Table 2.** Multivariate model predicting likelihood of children in the Lower Mississippi Delta (LMD) meeting an Adequate Intake (AI) of calcium by age, income, ethnicity, sex, and use of nutritional-assistance programs

Variable	Intercept	Odds Ratio	P value*
<b>Energy†</b>		1.17	<.0001
<b>Sex</b>			
Male		1.69	.0372
Female		1.00	
<b>Race</b>			
White		2.03	.0205
African American		1.00	
<b>Adolescent females, ages 12-17</b>			
White		2.78	.2659
African American		1.00	
<b>Nutrition assistance</b>			
Participate		1.88	.0171
Don't participate		1.00	
<b>Age increase‡</b>		.72	<.0001

\* P value indicates significance  $< .05$ .

† For every increase of 100 kcal.

‡ For every one-year increase in age.

calcium intake with one 8-oz. glass of skim milk.

The current study confirms the low calcium intake of children, especially African American children and females, which is consistent with results of previous studies.<sup>48-52</sup> Real or perceived lactose intolerance could explain the lower calcium intake among African American children. However, results of double-blind, randomized, crossover trials indicate that most lactose-intolerant individuals can tolerate one cup of milk with each meal.<sup>53-54</sup> Similar to national data,<sup>2</sup> LMD children get most of their calcium from milk products (28%) and grains (10%). Top sources of calcium for African American and White LMD children were similar in all age groups. Milk was the highest contributor to calcium in the diet of all the LMD children, which indicates that African American children consume milk products. One notable difference was that whole milk was the top calcium source for 9- to 17-year-old African

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American children compared with 2% milk in the same age group of White children. One of the goals of Healthy People 2010 is to increase children's calcium consumption to  $\geq 1300$  mg/day.<sup>14</sup> Children in both the US and LMD samples fall short of this goal by  $>350$  mg/day, or one serving of milk. Further, the percentage of children in both the United States and LMD meeting the recommended AI for calcium decreases with age. Possible interventions with LMD African American children should focus on increasing consumption of low-fat dairy and other dietary sources of calcium.

Children in households that participate in nutrition-assistance programs are 1.88 times more likely to meet the AI for calcium. Other research has shown that children have better nutrient intake when they participate in nutrition-assistance programs.<sup>18,55</sup> Though mean dietary calcium intake is lower in children in households who participate in nutrition-assistance programs, median intake is higher, which indicates that the mean may have been unduly influenced by extreme consumers.

### Limitations

While these data have identified problems in the calcium intake in the LMD, limitations are associated with data collection and analysis that prompt the use of prudence in interpreting the findings. Inherent limitations exist in dietary data collection through self-report, such as underreporting of food intake and therefore nutrient intake.<sup>56</sup>

Underreporting could tend to exaggerate inadequacies in intake.

The telephone method for collecting the 24-hour dietary recall is an effective means of collecting dietary information.<sup>19,57</sup> A study conducted by Casey et al<sup>57</sup> compared 24-hour dietary recalls collected over the telephone to in-person recalls collected in CSFII 1994–1996. Results indicated no significant differences between telephone interviews and 1996 CSFII results. Therefore, differences between FOODS 2000 data and CSFII data should not be attributable to method of data collection.

In this study, DRI comparisons were made on the basis of a single 24-hour recall, which may not give precise individual estimates.<sup>58</sup> However, group means were used to minimize individual variation. The AI was used for comparison purposes, which might overestimate the level of inadequacy.<sup>2,22</sup>

### Recommendations

When planning nutrition interventions in the LMD, knowledge of current estimates of food and nutrient intake is critical. Current national surveys do not include region-specific dietary data on all regions of the United States. Based on the current findings, calcium intervention in adolescent children is warranted, with particular focus on African Americans and 9- to 17-year-old girls. The message should include the effect of calcium intake on weight and hypertension since these are important concerns for the African American adult population.

Increasing calcium consumption in children from households that participate in nutrition-assistance programs should also be a focus. The message should include cost-effective methods for purchasing calcium-rich foods. Schools, especially middle, junior high, and high schools, need to promote low-fat milk consumption. Low-fat milk could be easily accessible in school cafeterias, and milk vending could replace soda vending. Further studies are needed to explore barriers to consumption of other calci-

um-rich foods, especially in specific regions such as the LMD.

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